

Inference in Hybrid Bayesian Networks

state-of-the-art

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Hybrid Bayesian Networks

- Hybrid models are used for representing uncertainty in domains containing not only discrete variables, but also continuous values such as distance, temperature or location.
- The introduction of continuous variables in a graphical model has several particularities: factors that imply continuous variables and marginalization
- The complexity of these algorithms is so high that present significant challenges to perform

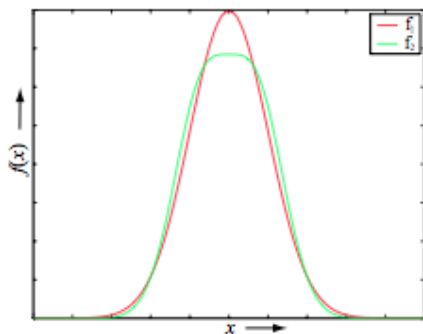
- Heskes and Zoeter (2003) applied a generalized belief propagation to approximate inference in HBNs

$$\text{mean} : E[x], \text{covariance} : E[(x - E[x])(y - E[y])]$$

- But Schrempf and Hanebeck, 2004 considered that using first two moments is a drawback

Hybrid Bayesian Networks

The drawback of using only the first two moments to describe a continuous density lies in the fact that there exist many densities having identical first moments. This can be seen in figure 1 for the functions $f_1(x) = N(x, 0, 1)$ and $f_2(x) = 0.5N(x, -\sqrt{0.5}, \sqrt{0.5}) + 0.5N(x, \sqrt{0.5}, \sqrt{0.5})$ where $N(x, \mu, \sigma) = \frac{1}{\sqrt{2\pi}\sigma} \exp -\frac{1}{2} \frac{(x-\mu)^2}{\sigma^2}$ is a Gaussian density with mean μ and deviation σ . Both densities (f_1, f_2) have mean 0 and variance 1 which are the first two moments.



Barry R. Cobb and Prakash P. Shenoy proposed alternatives to discretization for solving HBNs.

- 2004: Deterministic variables with *Conditional Linear Gaussian (CLG)*
- 2005: Continuous variables not normally distributed with *Mixtures of Truncated Exponentials (MTE)* potentials
- 2006: Discrete and continuous variables with *Mixture of Gaussians (MoG)* BNs

In a general HBN with nonlinear and/or non Gaussian variables there is no existing method that could produce exact posterior distribution.

- *Hybrid Loopy Belief Propagation(HLBP)*
- *Loopy Belief Propagation(LBP)*
- *Nonparametric Belief Propagation(NBP)*

Sun et al., 2010 describe an algorithm able to provide an exact solution for polytree networks, and approximate solution by loopy propagation for general hybrid models.

- *Direct Message Passing for Hybrid Bayesian Network* (DMP-HBN)

Conclusions and future research

In this short state-of-the-art we have reviewed some of the most important research papers on inference in Hybrid Bayesian Networks published to date and the algorithms proposed to revolve it. The quality of these algorithms, quality as the performance, is constantly evolving and improving. Being this aspect the main line of research actually.